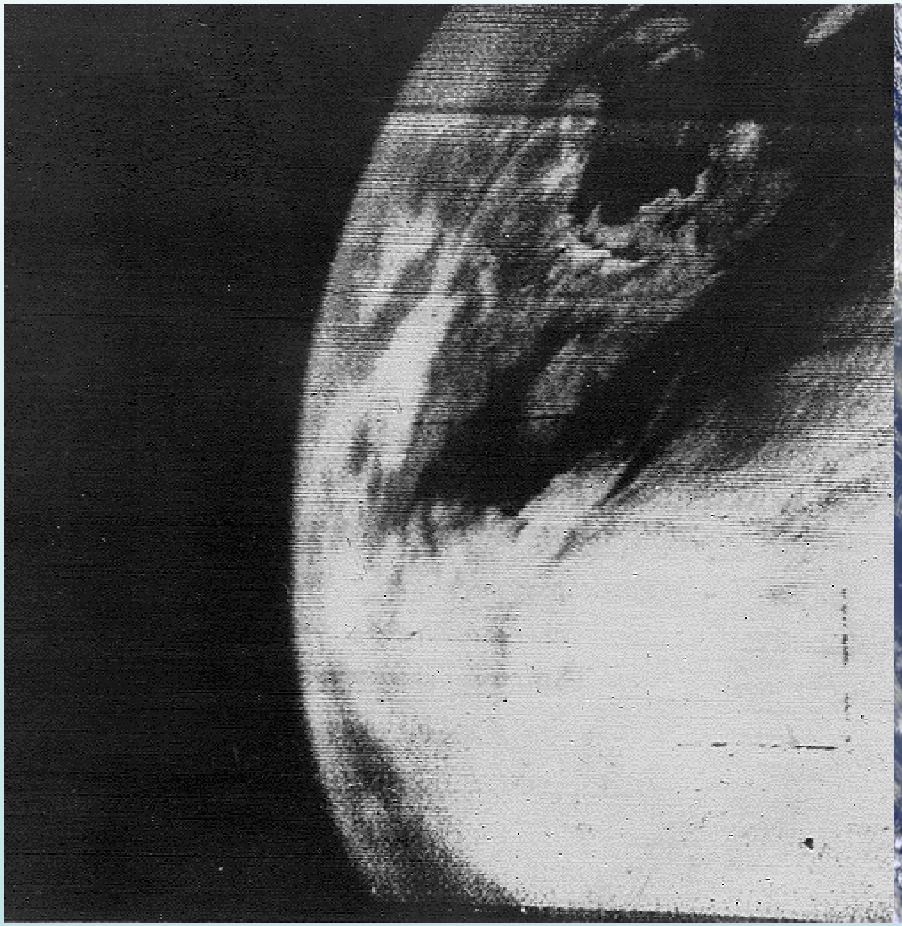
From TIROS and DMSP to the Future

…Tomorrow is here today

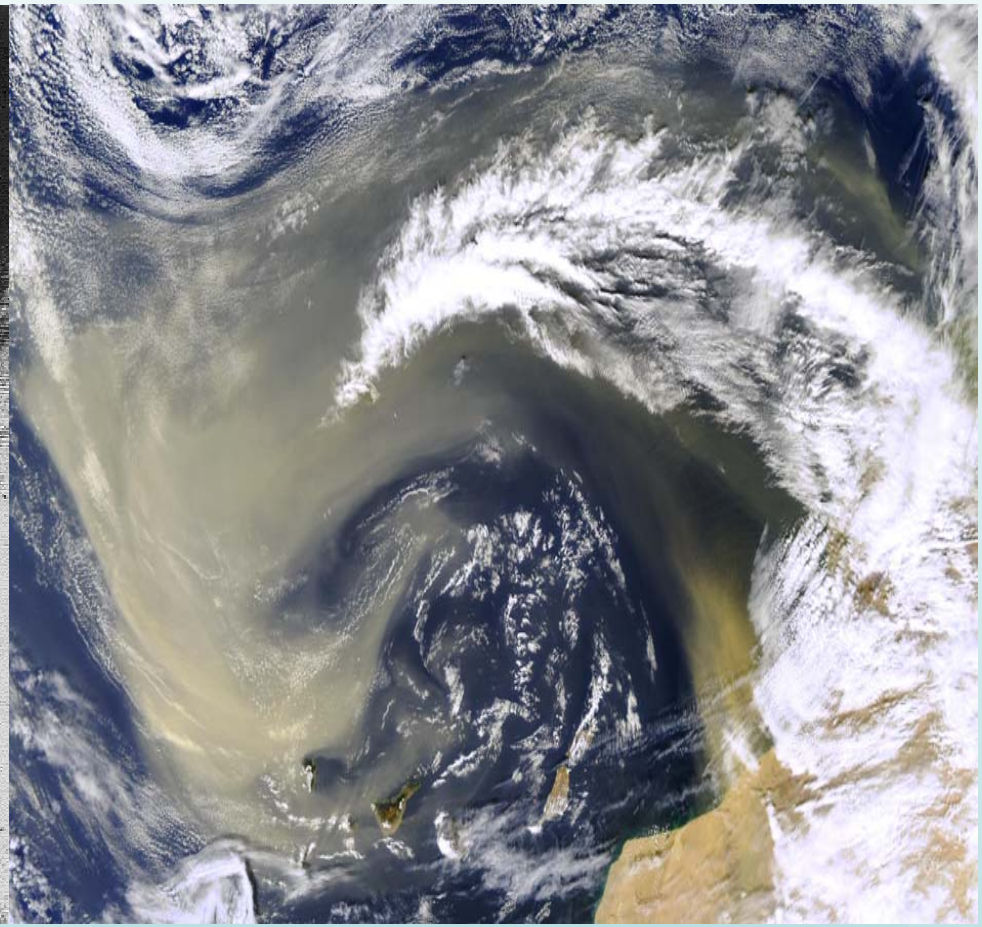
Direct Readout Conference of the Americas

Building A More Capable System -- The Historical Context

First Image from TIROS-1



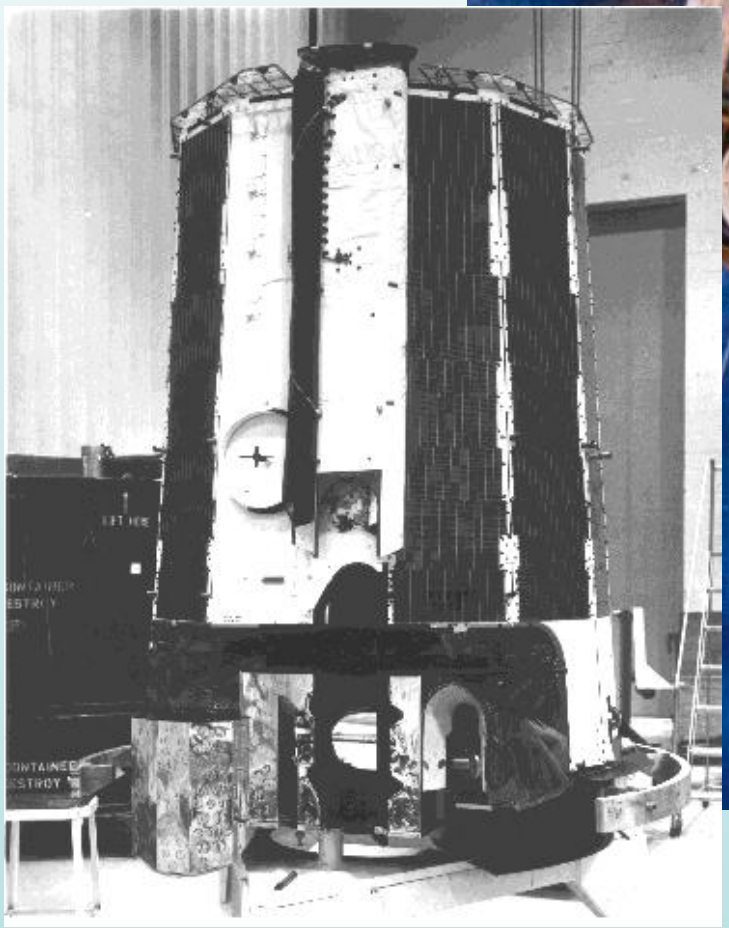
EOS-Aqua MODIS Image-250 m

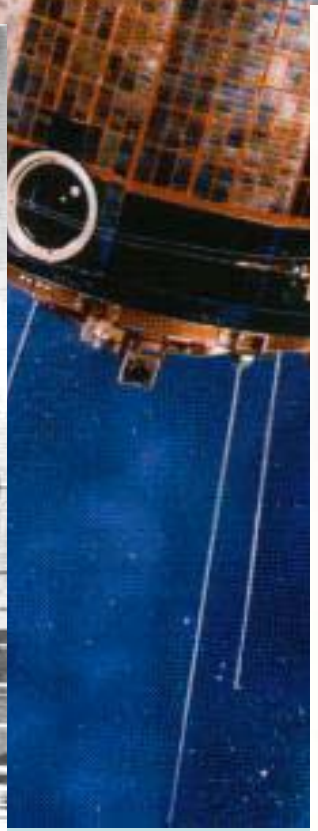


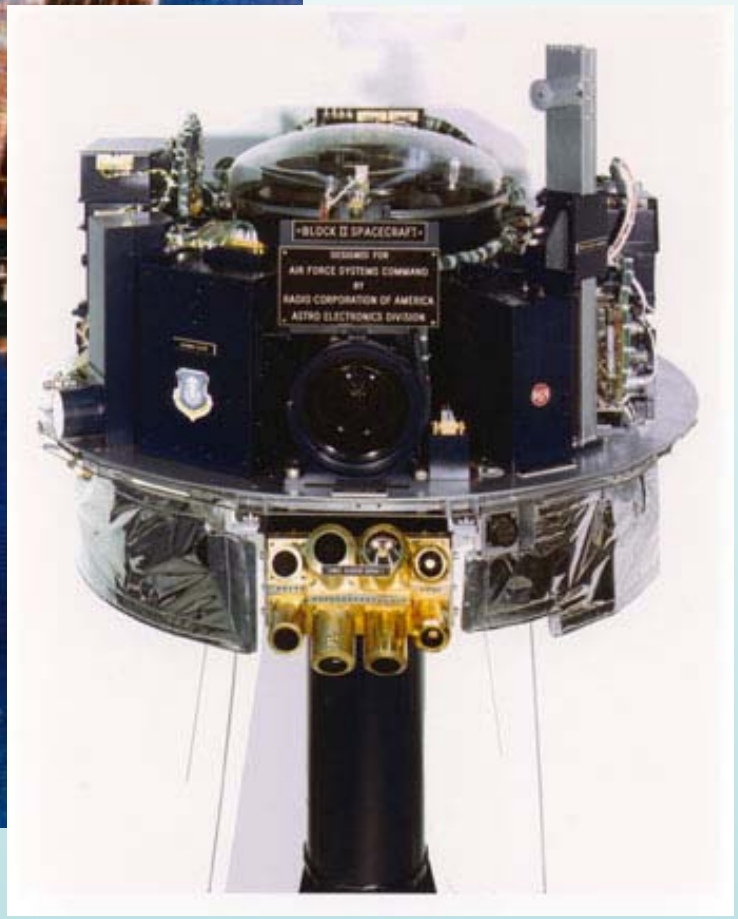
Saharan Dust off the Canary Islands 18 February 2004

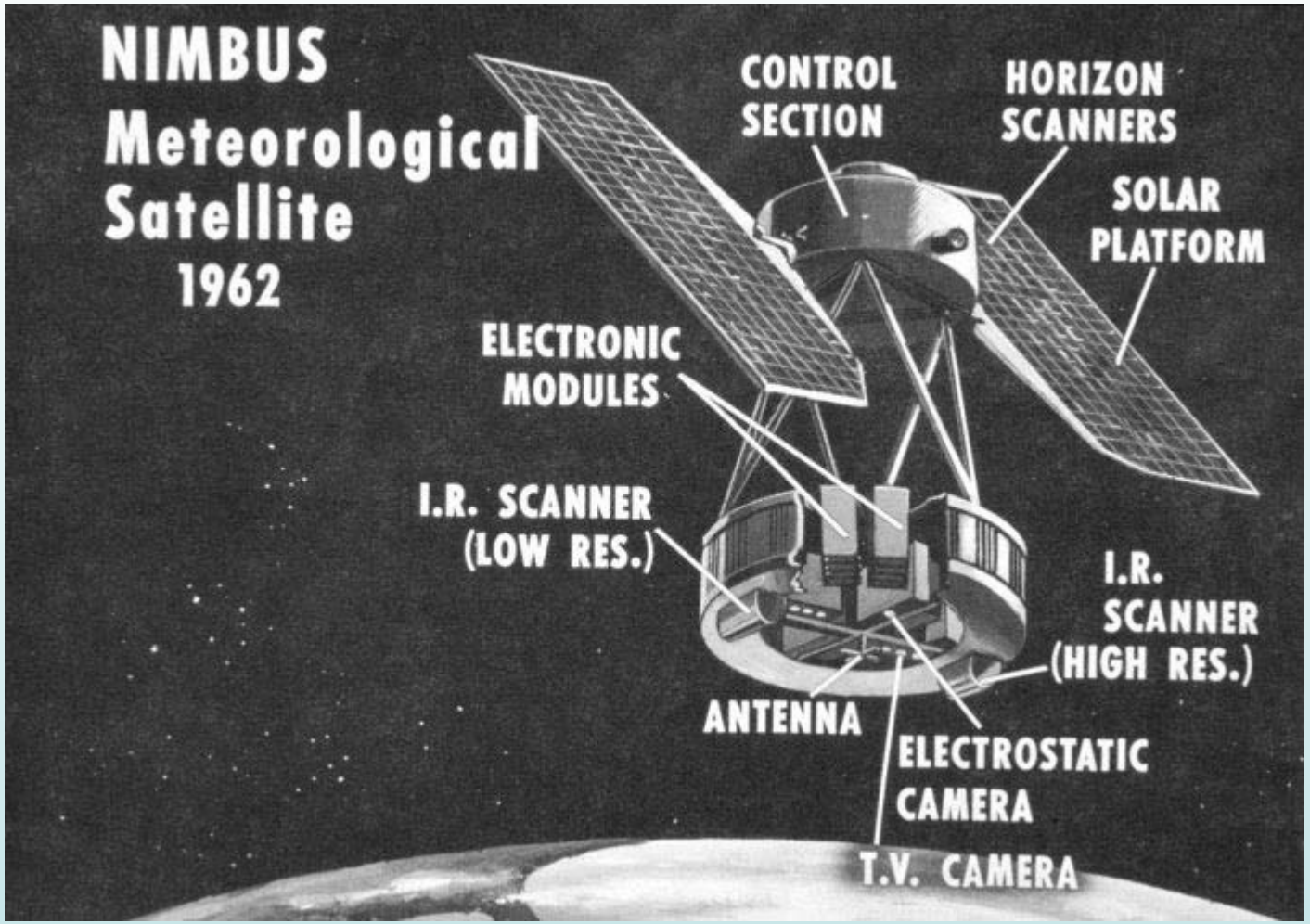
FIRST COMPLETE VIEW OF THE WORLD'S WEATHER

Defense Meteorological Satellite Program









Nimbus 1 launched on Aug 28, 1964, 2 notable firsts
-- first three-axis stabilized metsat
-- first sun synchronous satellite

The Challenges

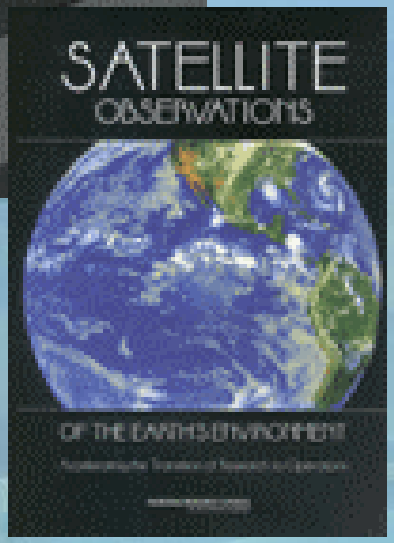
Transitioning Research to Operations

NRC , 2000

- Transition from research to operations remains an item of great interest and concern to the National Academy
- Identified and agreed to as a policy element in the new National Space Policy

NRC, 2000

NRC, 2003



Growing data volume and rate could stress processing and archive

1960 - 2010

DMSP
(Defense Meteorological Satellite Program)

POES
(Polar Orbiting Operational Environmental Satellites)

Sensor data rate: 1.5 Mbps
Data latency: 100-150 min.

1.7 GigaBytes per day (DMSP)
6.3 GigaBytes per day (POES)

2000 - 2010

NPP
(NPOESS Preparatory Project)

EOS
(Earth Observing System)

15 Mbps sensor data rate
Data latency: 100-180 min.
Data availability: 98%
Ground revisit time: 12 hrs.

2.6 TeraBytes per day (EOS)
2.4 TeraBytes per day (NPP)

2010 – 2020+

NPOESS
(National Polar-orbiting Operational Environmental Satellite System)

20 Mbps sensor data rate
Data latency: 28 min.
Data availability: 99.98%
Autonomy capability: 60 days
Selective encryption/deniability
Ground revisit time: 4-6 hrs.

8.1 TeraBytes per day

Imagine . . .

What if . . . ???

Can we make the future what we want??

Direct Readout Conference of the Americas

I envision four distinct possibilities in the NPOESS era

- *Training*
- *Cooperation in regional data networks*
- *Cooperation in instrument development to meet new needs*
- *Cooperation at the mission level*

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We get to write the history of the future

- *We get to decide if we will follow the ideas of the past or try new things*
- *What says that we can't take new and old Ideas and find new solutions to old problems?*

Training

Training

- **You have heard several groups from the United States discuss the superb tools they are developing to train meteorologists in the use of existing and future satellite capabilities**
- **You also heard that the biggest weakness is our ability to provide these tools in the languages of your countries**
- **Why don't we discuss cooperative agreements where we supply the technical products and you have your scientists, engineers and meteorologists provide the translation**
  - Your meteorological services could provide equivalent imagery that depicts your region
  - Our training groups would then integrate the results into a finished product

Regional Data Sharing

Regional data sharing … what am I thinking about?

- **Historically, satellites stored high resolution data because they didn't have the RF links to send the data down**
- **Realtime data was normally limited in quality and quantity**
- **Data transfer was limited because of limited ground communication links**
- **So …**
  - Lets look at it with a new set of eyes

Consider the NPOESS concept, but use the ideas a different way

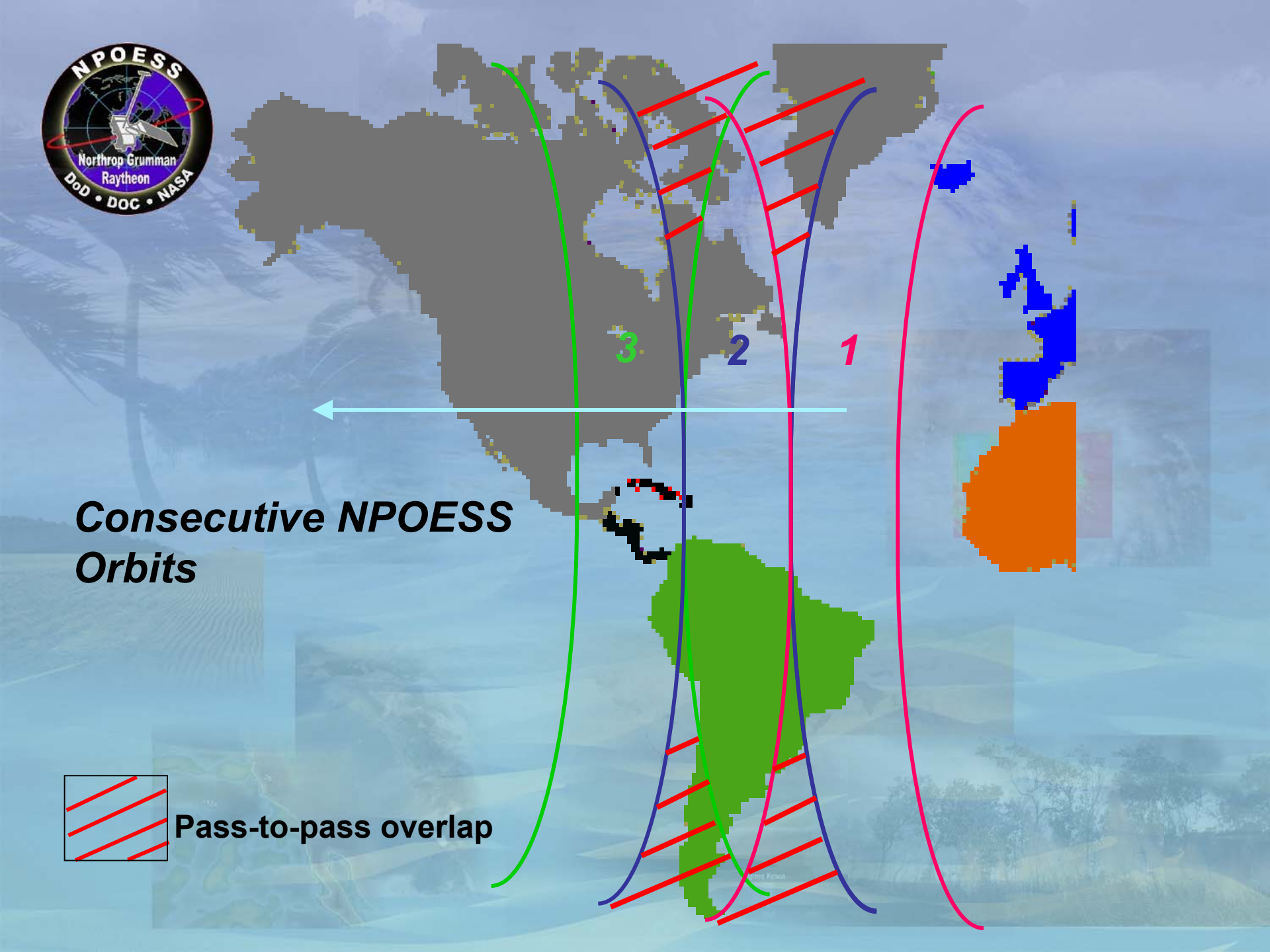
- **What makes NPOESS unique and capable?**
  - SafetyNet™
  - Full instrument data set send down over X-band realtime link
  - Multiple instruments on the same platform
    - Even potential for high resolution multispectral imaging in the 2130 orbit with Landsat Data Continuity Mission
- **What are NPOESS' weaknesses?**
  - SafetyNet™ is a playback-only system whose data may not be of interest or even relevant (because it was recorded somewhere else)
  - Readtime links don't cover continent-sized areas in a single pass
  - Weather comes from somewhere else, perhaps out of the realtime field of view

NPOESS' Greatest Facilitators

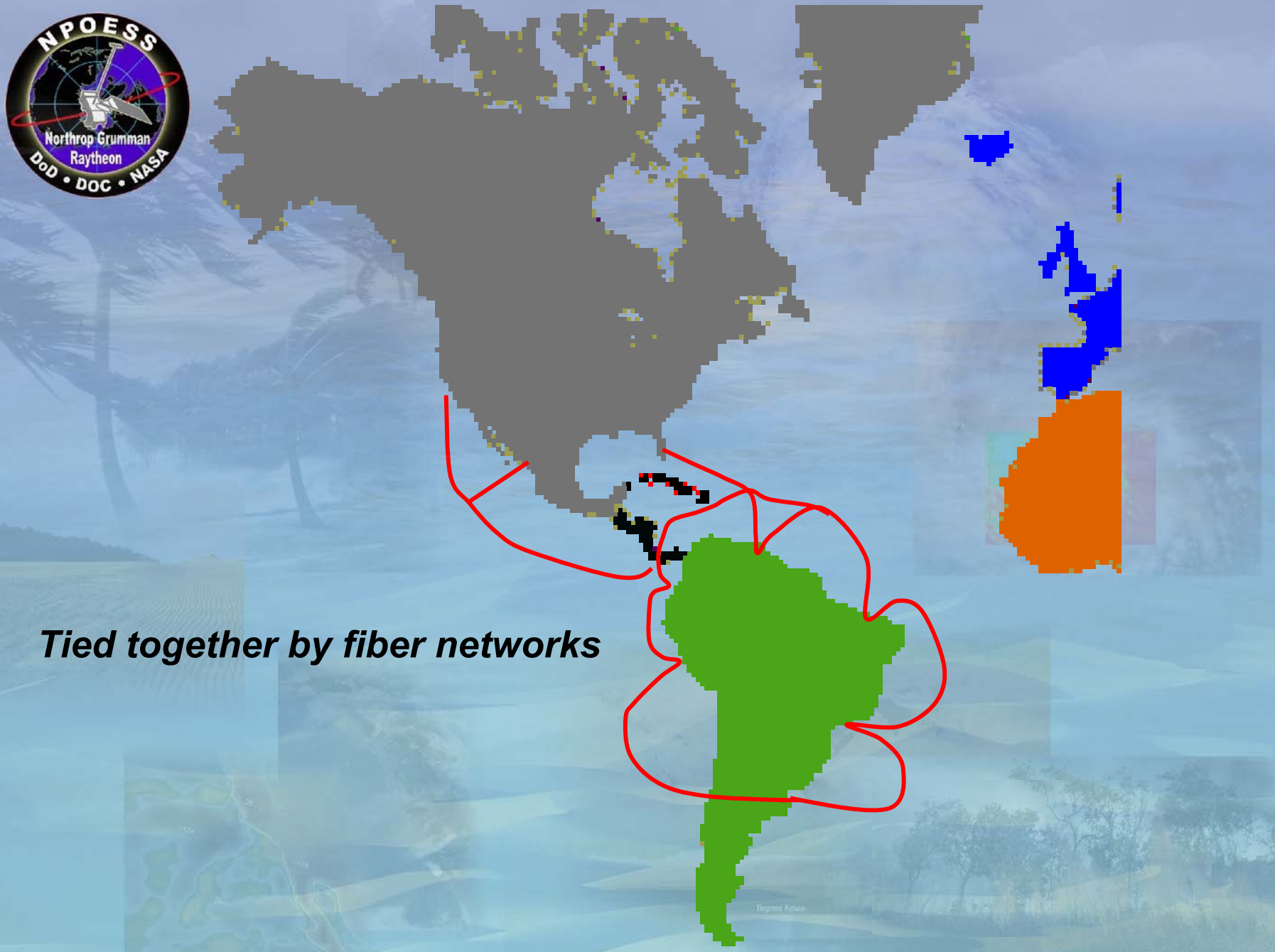
- **SafetyNet™ makes NPOESS possible**
  - The worldwide fiber net makes SafetyNet possible
- **A standard software package for users opens tremendous potential**
  - NPOESS data processing software is being designed to operate on a family of computers, driven by
    - User timelines
    - User needs

Let’s Looks At One Possibility

NPOESS
Northrop Grumman
Raytheon
DoD • DOC • NASA


NPOESS
Northrop Grumman
Raytheon
DoD • DOC • NASA
3
2
1
Consecutive NPOESS Orbits
Pass-to-pass overlap

5 – 6 stations can cover all of the Americas south of the US



Tied together by fiber networks

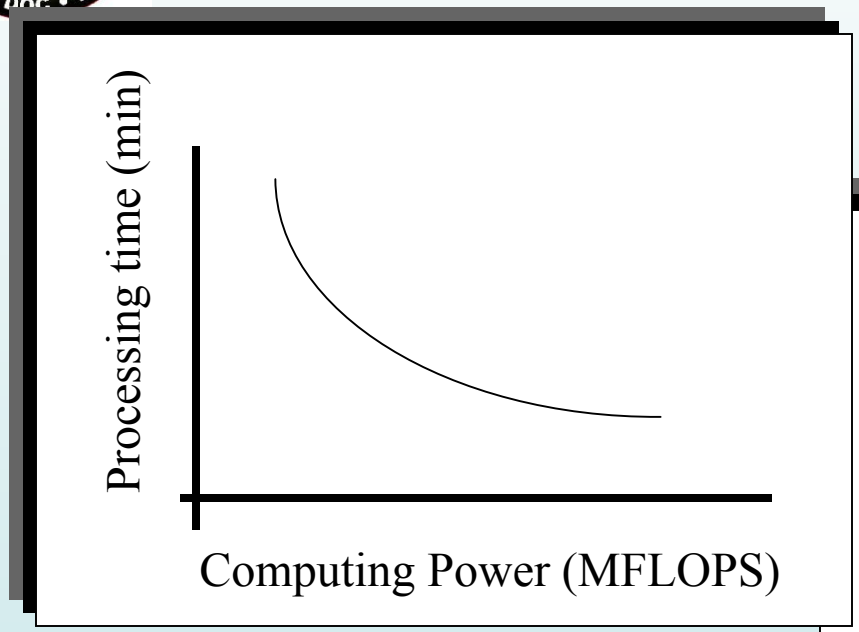
Result:

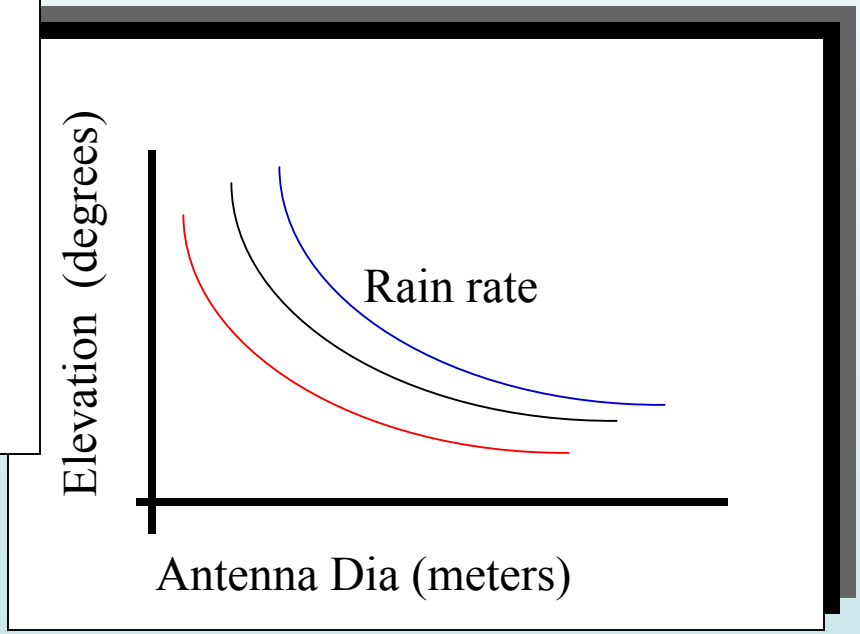
- ***Continental data coverage available locally in near real time***
- ***Adjacent ocean areas available from NOAA after NPOESS playback***

Pass-to-pass overlap

Is This Possible?

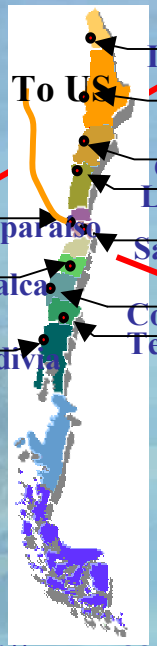
Data processing design trade example





NPOESS approach allows user to buy commercial, local equipment to meet their specific needs, based on their performance requirements

So, is it possible?



Absolutely!!

The critical facilitator exists NOW!!

http://www.comsatinternational.com/network/

Preplanned Product Improvement

Preplanned Product Improvement on NPOESS

- Tropospheric winds
- Neutral winds
- All weather day/night imagery
- Coastal sea surface winds
- Ocean wave characteristics
- Surf conditions
- Oil spill location
- Littoral current
- CH4 column
- CO column
- CO2 column
- Optical background
- Sea and lake ice
- Coastal ocean color
- Bioluminescence potential
- Coastal sea surface temperature
- Sea surface height coastal
- Bathymetry
- Vertical hydrometeor profile
- Salinity

IPO P^{3}I

Announcement of Opportunity

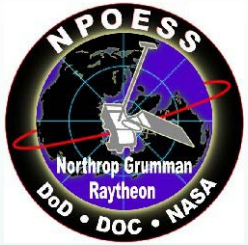
Payload on NPOESS

Your Ideas and Needs

Capability

- **NPOESS designed with built in margin for P3I**
  - Set at 25% most heavily loaded s/c (1330) payload capability
    - 365 kg
    - 326 w
- **No constraints on mission**
  - Meeting NPOESS requirements is a “bonus”
- **Data release conditions can be negotiated**

Mission Cooperation



Mission Cooperation

- **The first NPOESS will carry**
  - Moderate resolution imagery (400 – 800 m visible and IR)
  - Microwave imagery for
    - Soil moisture
    - Sea ice edge and motion
  - Perhaps a higher resolution, multispectral Landsat imager
    - 10 – 30 m resolution
- **Eumetsat's Metop will carry**
  - IASI infrared sounder
  - US' Advanced Microwave Sounding Unit (AMSU)
  - Scatterometer
- **What we don't have**
  - Imaging radar
  - Altimeter

What could be done?

- **As new national missions come on line, consider NASA's "train" concept**
  - Closely spaced satellites that see the same environmental phenomena
  - Maintain separate schedules, ground stations, data processing
  - Sharing data between users

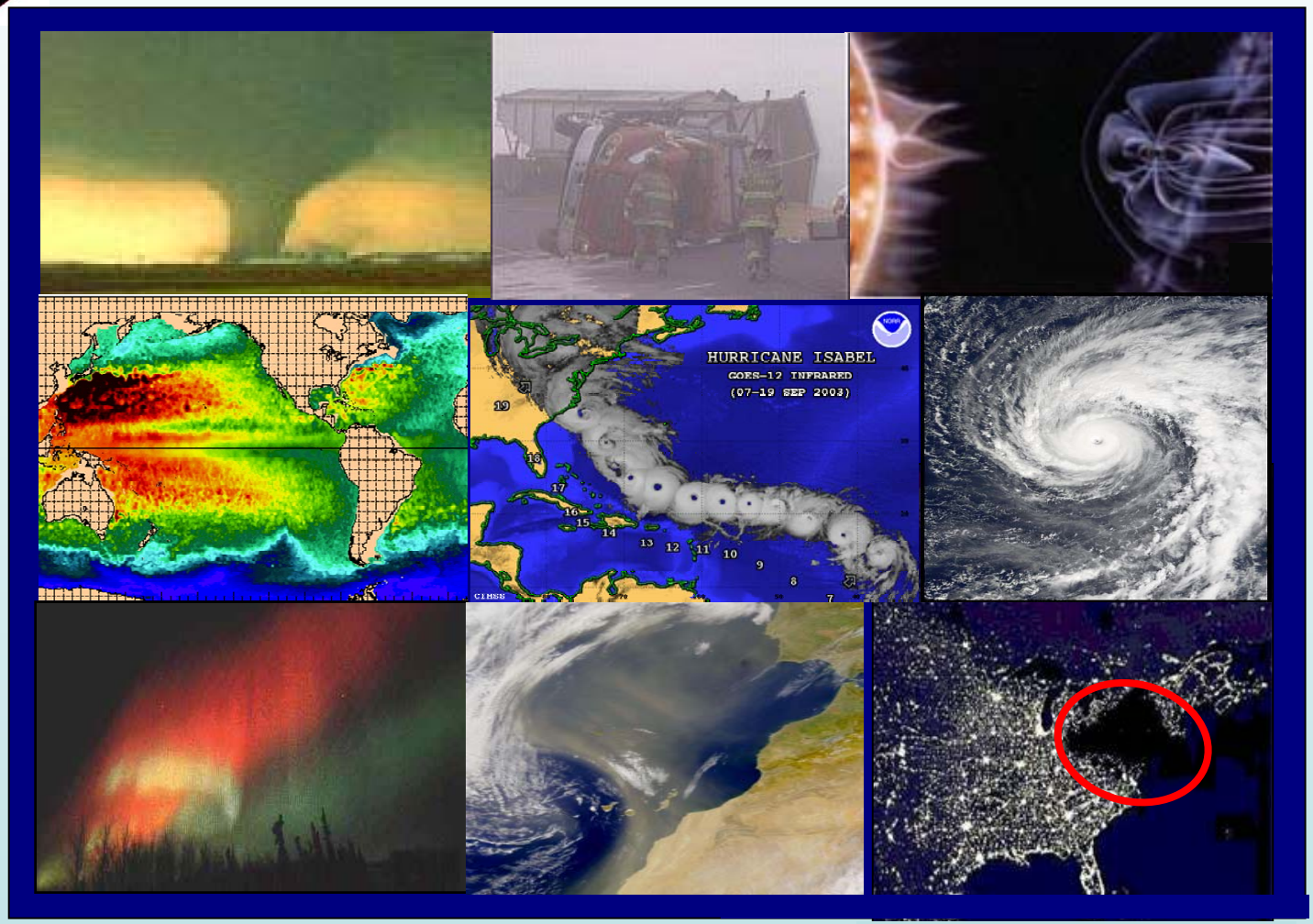
A little movie follows that shows fused data – land use, weather, elevation, ocean color

… Imagine what we could do if we planned it …

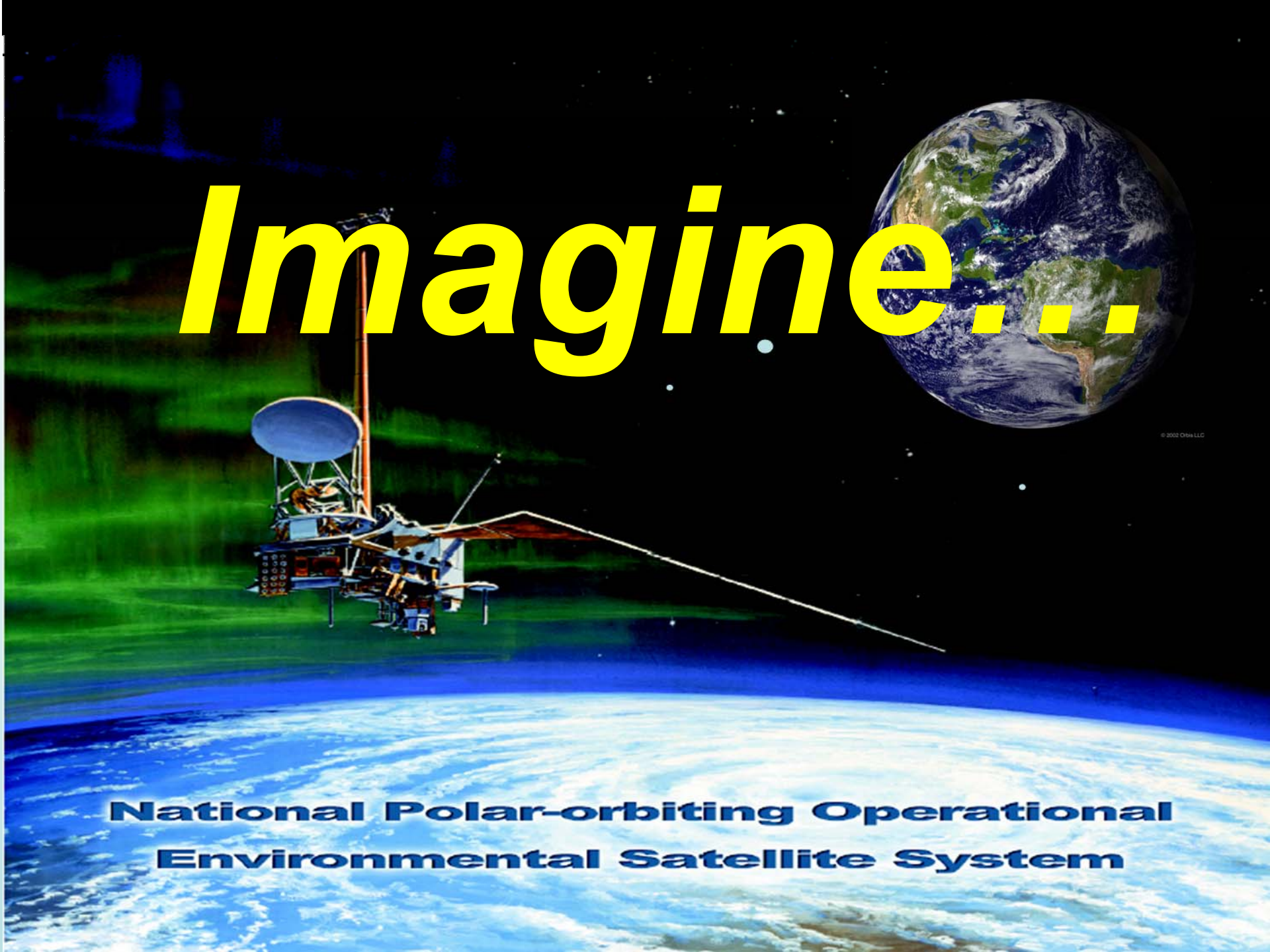
Fused data sets give value greater than the sum of their parts ..

Graphic courtesy of NASA

Summary



The Data Will Be Out There … It's Up To Us To Make It Happen


Imagine...
National Polar-orbiting Operational
Environmental Satellite System